PATENT SPECIFICATION

DRAWINGS ATTACHED

862,795

Date of Application and filing Complete Specification: June 9, 1959.
No. 19782/59.
Application made in France on June 12, 1958.
Application made in France on Dec. 10, 1958.
Application made in France on May 27, 1959.
Complete Specification Published: March 15, 1961.

Index at acceptance:—Classes **8(2)**, D3(C: E2A); **46**, D1(B4: U), D2J1(C1: C3: D), D3B; **81(2)**, YX1; **99(2)**, P1A(9: 10: 18B: 19A: 19B: 27), P1B(1: 7); **and 122(3)**, N1(B: H).

International Classification:—**A61b. B01d. F06j, l.**

COMPLETE SPECIFICATION

Tubular Members Provided with Corrugated Walls and method for producing same

We, BODIN-GIRIN & CIE, TISSUS INDUSTRIELS, SOCIÉTÉ ANONYME, of 2, Rue Boucher-de-Perthe, Tarare, Rhône, France, a body corporate organised under the Laws of France, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Our invention has for its object a method for producing tubular members having corrugated walls and the products obtained through said method.

The expression "corrugated walls" is intended to convey the meaning that the generating lines of the tubular members have a deformed undulating shape.

Various materials are known to which may be bestowed a permanent deformation upon subjection to a thermal or thermo-chemical treatment which will be defined hereinafter as a "fixing treatment."

The present invention covers more particularly a method for producing such tubular members having corrugated walls and provided, with reference to smooth-walled tubes, with improved properties as to resistance against crushing and transverse rigidity, together with an increased ease of elongation and longitudinal bending.

The invention has also for its object the production, starting from corrugated tubular members, of various products such as aortic prostheses, filtering elements, reinforced tubes, packings, washers and the like. Tubular members obtained by the improved method according to the invention are particularly suitable for such applications.

Our improved method for producing tubular members with corrugated walls consists in preparing through weaving a smooth-walled tubular element comprising a thermo-setting material, formed in the wall of the tubular element a series of corrugations and subjecting the tubular member thus obtained to a fixing treatment.

The features of the invention will apppear readily upon reading of the following description of a number of embodiments of the method and of the product obtained, as illustrated by way of example in the accompanying diagrammatic drawings, wherein:

Fig. 1 illustrates an embodiment of the method according to the invention.

Fig. 2 shows a former adapted to serve for a modified embodiment.

Figs. 3 and 4 illustrate two further modifications of the method.

Figs. 5 and 6 illustrate a tubular member according to the invention, respectively before and after heat treatment.

Fig. 7 shows a filter of the plug type obtained from a tubular member according to the invention.

Fig. 8 shows a reinforced tubular member executed according to a further feature of the invention.

Fig. 9 shows a tubular member with a corrugated wall in longitudinal cross-sectional view.

Figs. 10 and 11 show packings obtained with a member according to Fig. 9.

According to a first embodiment (Fig. 1), there is introduced inside the original tube 1 a helical spring 2, the convolutions of which are spaced, said spring including one or more elementary coils, whether stretched or otherwise, in contacting relationship with the tube. There is then wound over the outer surface of the tube a suitably stretched thread 3 extending between the successive convolutions of the spring. Said thread may be either non-sensitive to the modifications in temperature and act through its original tensioning or else, it may be subjected during treatment to a predetermined shrinking.

[*Price 3s. 6d.*]

Price 25

The whole arrangement including the spring, the tube and the thread is then subjected to a heat treatment for instance inside a kiln, either in the presence of the outer atmosphere, or in vacuo or again inside a body of steam; or else, it may be immersed in a suitable gaseous or liquid medium, so as to produce the proper shaping of the tube. The spring is taken out of the tube only after cooling of the tube thus deformed and fixed.

For instance, starting from a tube of a diameter of 25 cm. made of woven polyethyleneglycolterephthalate, said tube is fitted over an unstretched spring, the convolutions of which are spaced. There is then wound over the outer surface of the tube and between the locations of the successive wire convolutions a thread of stretched polyvinyl chloride, after which the tube is introduced into a kiln at 65° C, the temperature being raised within 40 minutes to 185° C; under the action of heat, the polyvinyl chloride thread shrinks by about 30% and the convolutions engage the fabric which is fixed in its deformed condition.

The tube retains its shape after removal of the spring and it is possible to obtain thus a shaped support adapted to be subjected without any further deformation to fluidtightness, impregnation, coating and the like treatments, as described hereinafter.

It is also possible to give the tube formed according to the invention a permanent elasticity by releasing the spring during the fixing treatment.

For instance, starting from a tube of a diameter of 12 mm. woven with crimped polyacrylonitrile of the type used for aortic prostheses, said tube is fitted over an inner stretched spring. There is wound, as precedingly, between the locations of the spring convolutions a thread of polyvinyl chloride, the shrinking of which, when heated, reaches 30% and the whole arrangement is inserted into a kiln at 65° C.

The temperature is gradually raised to 160° C and, after one hour, the spring is released and the tube is left inside the kiln during about 20 further minutes. The spring is then allowed to cool, while the outer thread remains positioned over the tube.

The prosthesis when released appears then as pleated along convolutions, while it shows the desired improved resistance against crushing, yieldingness and elasticity of an absolutely novel type.

The spring may be released in a sudden or gradual manner as produced for instance by mechanical means. It is possible to hold the spring stretched by a wire, of which one end is stationary, while the other is secured to a terminal convolution of the spring, said wire releasing the spring when it reaches its melting point.

It is also possible to introduce into the tube before deformation of the latter and treatment thereof, a cylindrical former of the type shown at 5 in Fig. 2, the outer wall of said former being provided with a groove 6. There is then wound, as precedingly, a suitably selected thread round the tube in registry with said groove 6; the former may, in fact, be constituted by a mere screw or worm.

It is also possible to resort to two springs 8 and 9 having substantially equal diameters and arranged coaxially inside and outside the tube 1 to be formed, the fixing being obtained through the natural shrinking of the tube during the heat treatment (Fig. 3).

According to a further modification illustrated in Fig. 4, the tube 1 to be formed is fitted inside and in contact with a metal tube 10, the inner surface of said tube 10 being provided with ribs or like unevennesses adapted to be transferred onto the tube to be formed. To allow this transfer, there is introduced into the plastic tube 1 a third yielding tube 11 which is subjected to internal pressure during the heat treatment and the thrust exerted by which constrains the tube 1 which is being formed to mate the shape of the outer metal tube 10.

According to a modification of the method disclosed and for executing tubular members with corrugated walls, chiefly for aortic prostheses, a tube is woven, the smooth wall of which includes a succession of annular areas constituted by weft threads made of at least one thermo-shrinking material, the shrinking properties of said threads under the action of heat differing between the odd and even alternating areas. The controlled shrinking of said weft thread is provided by heating, so as to obtain a ringed appearance for the tube. A tubular member obtained in accordance with said method is illustrated in Figs. 5 and 6. Turning to Fig. 5, a woven tube 20 of which the warp is constituted by a thread of crimped polyacrylonitrile weighing 2×90 deniers is associated in succession and alternatingly with the same crimped thread to form an annular area 21 (eight successive shots) and with an ordinary 180 denier thread which is not shrunk to form an annular area 22 (four successive shots). The tubular member thus obtained is fitted over a tubular core and is heated therewith inside a kiln during 30 minutes, which produces a shrinking of the non-shrunk threads in the area 22. The woven tube is allowed to cool and its components are compressed with reference to each other, which leads to the production of a ringed appearance. The tube is then heated at 130° during 45 minutes and there is obtained thus a ringed elastic tube which is sufficiently rigid for it to be necessary to incurve it without any crushing (Fig. 6). Such a method serves in particular for the obtention of aortic surgical prosthesis.

In the example described, it is possible to use, for the successive weft threads, threads obtained from the same material, say a poly-

acrylonitrile resin. It is obviously possible to resort to threads of a different nature for the weft, such as polyacrylonitrile and polyvinyl chloride, or the like.

The use of the tubes thus obtained is obviously not limited to aortic prostheses and another interesting use of such tubular elements consists in the execution of tubular plug-shaped filters, which have the advantage over other filters of the same height of being capable of use without any reinforcement or support to serve in particular as gas filters, chiefly for air, and as liquid filters; one of the ends of the tubular elements forming said filters may be closed through weaving in this type of application. Furthermore, it is also possible to execute batteries of tubular filters of the plug type operating from the inside towards the outside or reversely and also to insert said plugs in a direction opposed to their normal location, i.e. in a manner such that the closed end of the filter may serve as a supporting part. Such a filter is illustrated diagrammatically at 30 in Fig. 7 as applied to the filtration of a liquid poured out dropwise at 31 through the nozzle 32.

It is also possible to produce with the tubular members according to the invention, reinforced pipes resisting both inner pressure and crushing. Such a pipe is illustrated diagrammatically in Fig. 8 in which annular members 40 made of the material sold under the Trade name "Nylon" are fitted over a corrugated tube 41 and are arranged each in one of the annular grooves formed on said tube. A textile or plastic ribbon 42 is then wound helically over the tube thus reinforced with a partial overlapping of the cooperating edges of said ribbon. Said ribbon is made of a shrinkable material and, consequently, when the ribbon or strip has been subjected to a suitable thermal treatment adapted to produce its shrinking, perfect cohesion is obtained for the components of the reinforced pipe. The ribbon or strip has, as a matter of fact, a tendency to mate intimately the outline of the reinforcing annular members 40 (Fig. 8).

In the case of an ordinary strip, it is preferable to make use of a ribbon, the warp of which is constituted by a shrinkable material, such for instance as polyacrylonitrile while the weft is made of a material which may be the same as for the warp, but which has already been subjected to shrinking. This cuts out the major part of the shrinking of the ribbon in a direction parallel with the axis of the tube.

It is also possible to resort to a ribbon or strip cut on the bias, in which case it is made entirely of threads which have not been subjected to shrinking. According to a modification, the reinforcing rings may, of course, be made of metal, and the outer casing may be made of a welded sheet of plastic material.

It should also be remarked that the tubular members which are generally obtained in accordance with the method disclosed have generally a porous structure. Certain applications require the use of rigid and yielding pipes having a fluidtight wall. This is, in particular, the case of pipes feeding a fluid such as the pipes of inhaling apparatus or again of the yielding connections between two rigid pipes.

In order to obtain such tubes, the corrugated rigid, possibly elastic tubular member, when obtained, is subjected to an operation having for its object to obtain fluidtightness. It is possible, for instance, to subject said pipe to a soaking operation, which would be be impossible in the case of a non-rigid tubular member such as that obtained at the outlet of the weaving loom.

It is possible to use for such a soaking an ethoxylin resin, such as polyepoxydiphenylol propane, such as the material sold under the Registered Trade Mark "Araldite"; it is thus possible, starting from a tube made of polyacrylonitrile, to obtain a yielding and fluidtight pipe of a very reduced weight, while it is practically inert with reference to most chemical reagents.

The tubular elements according to the invention allow also obtaining packings and washers, the method for producing which is illustrated diagrammatically in Figs. 9 to 11. According to said figures, a tubular element 50 is executed in accordance with the invention. To this end, a tubular fabric is woven, which includes warp threads of an inert material, such as polytetrafluoroethylene associated with weft threads made alternatingly of polytetrafluoroethylene and of non-shrunk polyacrylonitrile. After producing a shrinkage of the fabric, there is obtained a tube with a corrugated wall, similar to that of Fig. 9. It is possible to separate portions of the tube by cutting through the latter. For instance, the tube is cut along two transverse planes *aa* and *bb* or again along the planes *cc* and *dd* and the ringed structure of the tube allows, after crushing, in an axial direction, of the portion thus cut out, obtaining washer or packing elements which are illustrated by way of example in Figs. 10 and 11.

Said elements may be used in a particularly advantageous manner as packings and washers, by reason of the presence of polytetrafluoroethylene which is suitably inserted in the weave, said polytetrafluoroethylene showing as well known in the art, remarkable properties as to resistance to chemical reagents, together with an excellent behaviour under the action of heat.

It is also possible to reinforce in accordance with a well-known treatment the threads of polytetrafluoroethylene through a further incorporation of said material, which adheres to the threads.

It is also possible to resort to other materials used in conjunction with the thermo-setting

material for weaving, say asbestos threads, or again, it is possible to select a thread producing the shrinkage with a view to making said thread disappear readily after shaping of the packing. For instance, it is possible to use a thread of polyvinyl chloride, the shrinking of which may be equal to 15%; the packing obtained is heated to 140° C, so as to produce thus a melting of the thread and the remaining traces of the latter, if any, are removed through a suitable solvent, such as acetone, trichlorethylene or the like.

Of course, the invention is by no means limited to the embodiment described and illustrated, which has been disclosed solely by way of example. In particular, the material serving for the execution of the original tubular member may be selected within a very large range of materials and the shapes and sizes given to said tubular members may also vary according to the applications.

WHAT WE CLAIM IS:—

1. A method for producing tubular members with transversely corrugated walls, consisting in preparing through weaving a smooth-walled tubular element comprising a thermo-setting material, forming in the wall of said tubular element, a series of corrugations and subjecting the tubular member thus obtained to a fixing treatment.

2. A method as claimed in claim 1, according to which the corrugations are produced by subjecting the tubular element to shaping means and removing said shaping means after the fixing treatment.

3. A method as claimed in claim 1 or 2, according to which the original tubular element includes a succession of annular areas woven with weft threads constituted by at least one thermo-setting material, the shrinking properties of said threads under the action of heat differing for the odd-numbered and the even-numbered areas, the weft threads being subjected after weaving to a controlled shrinking through heating, so as to produce a tubular member having a ringed appearance.

4. A method as claimed in claim 2, according to which the forming means are constituted by a helical spring, the convolutions of which are not in joining relationship while the woven tubular element is fitted over said spring which is stretched or otherwise, after which a suitably stretched outer thread is wound over said tubular element along a path extending between the convolutions of said spring.

5. A method as claimed in claim 1, according to which the forming means are constituted by a solid cylindrical former, the outer wall of which is provided with a helical groove, and the tubular element to be deformed being fitted over said grooved wall and a suitably stretched outer thread being wound thereafter over the tubular element in registry with the groove to provide the corrugations in the tubular element.

6. A method as claimed in claim 4 or 5, according to which the outer thread is made of polyvinyl chloride or the like material adapted to shrink upon application of heat.

7. A method as claimed in claim 2, according to which the forming means are constituted by an outer tube inside which is fitted the tubular element to be deformed, while the inner surface is provided with a series of corrugations, said outer tube being associated with a yielding tube fitted inside the tubular element to be deformed so as to urge the latter against the outer tube, upon application of pressure.

8. A method as claimed in claim 2, according to which the forming means include two coaxial helical springs of substantially equal diameters, adapted to carry between them the tube to be formed, which latter is adapted to shrink upon application of heat.

9. A method as claimed in any of the preceding claims according to which the fixing treatment consists in introducing the tubular member obtained, carried by its forming means, inside a kiln in the presence of air or a suitable gas or in vacuo.

10. A tubular member provided with a corrugated wall obtained through the method claimed in any of the preceding claims.

11. A filter, chiefly a gas filter, constituted by a section of a tubular member according to claim 10, the end of which is possibly closed through weaving.

12. A fluidtight pipe obtained through impregnation of a tubular member as claimed in claim 10, with a material such as an ethoxylin resin.

13. A reinforced pipe wherein the reinforcing rings are arranged inside the corrugations of a tubular member as claimed in claim 10, a ribbon of a textile material capable of shrinking upon application of heat being helically wound round the reinforced pipe.

14. Packings and washers obtained through the axial crushing of sections of tubular members as claimed in claim 10, having for instance warp threads made of polytetrafluorethylene, said members being cut into sections along parallel transverse planes.

15. A method for producing corrugated tubular members with corrugated walls substantially as described with reference to and as illustrated in the accompanying drawings.

16. Tubular members substantially as described with reference to and as illustrated in the accompanying drawings.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1961.
Published by The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

Fig. 1

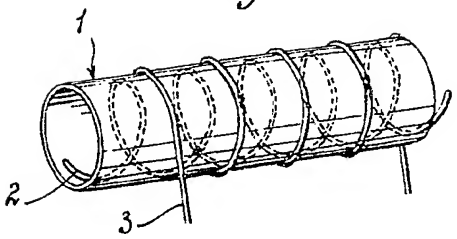


Fig. 2

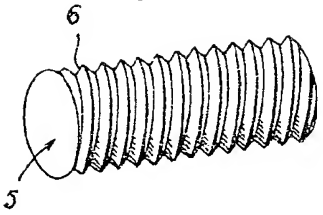


Fig. 3

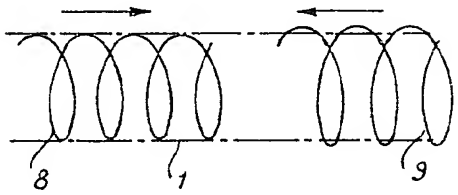


Fig. 4

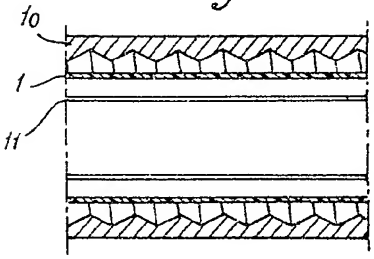


Fig. 5

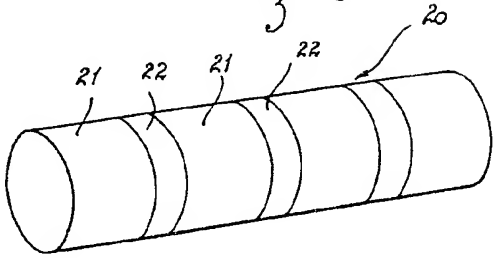
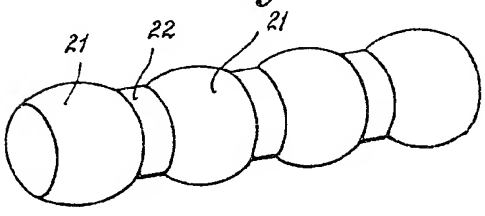


Fig. 6



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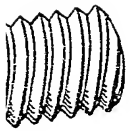

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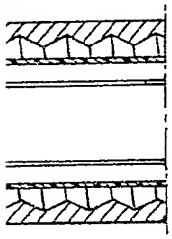


Fig. 7

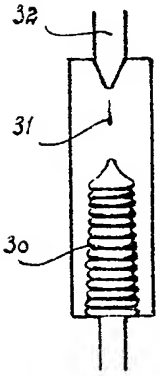


Fig. 8

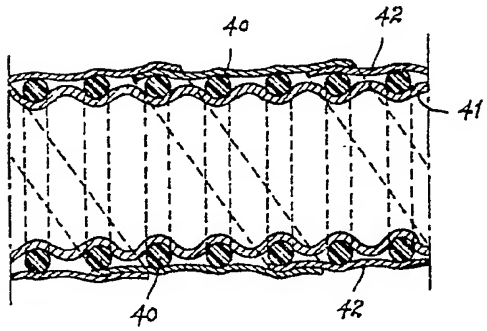


Fig. 9

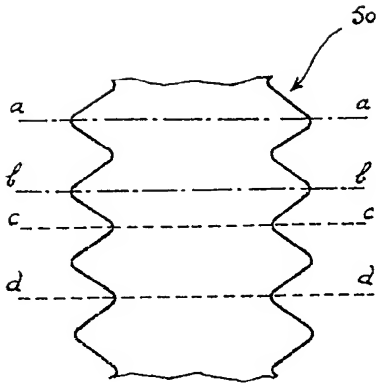


Fig. 10

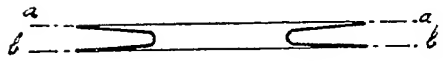
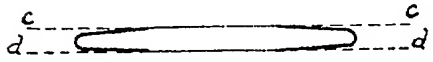


Fig. 11



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SHEETS 1 & 2

Fig. 1

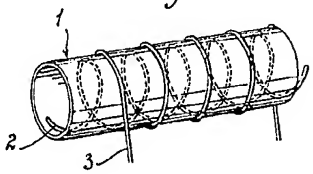

Fig. 2

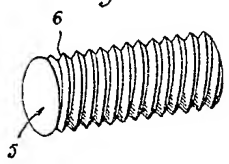

Fig. 3

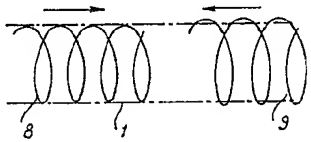

Fig. 4

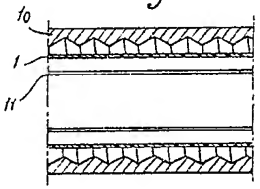

Fig. 5

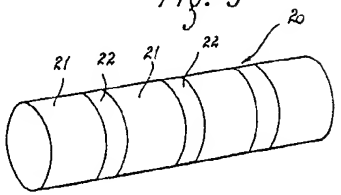

Fig. 6

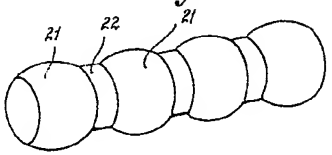

Fig. 7

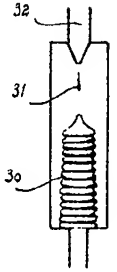

Fig. 8

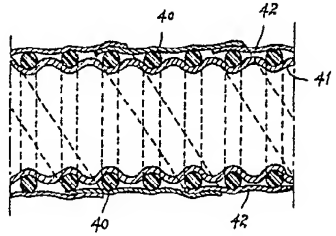

Fig. 9

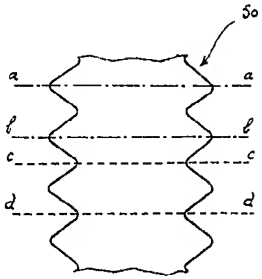

Fig. 10

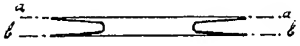

Fig. 11